ENVIRONMENTAL MONITORING AND GIS

Project title: **A Remote Sensing and GIS-Based Model of Habitat as a Predictor of Biodiversity**

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Objective: The major objectives of the research were to: 1) Quantify the spatial and temporal variability in montane meadows. 2) Develop a spectrally-based spatially-explicit model for predicting plant and animal (butterflies and birds) species diversity patterns in montane meadows. 3) Test the spectrally-based spatially-explicit model for predicting plant and animal species diversity patterns in montane meadows.

Findings: We sampled birds, butterflies, and plants for three years (1997-1999) in two regions of the greater Yellowstone ecosystem: the Gallatin National Forest and northwestern portion of Yellowstone National Park and Grand Teton National Park. We used satellite imagery to classify two types of wetland meadows and four sagebrush communities. In Grand Teton National Park, our overall accuracy of mapping sagebrush communities was 65%, and the highest for the mixed big sagebrush/low sagebrush community was 86%. Abundance of habitat specialist bird species was highly correlated with both meadow type and landscape variables. Butterfly species abundance and distribution was even more strongly correlated with meadow type (butterfly distribution was used to predict meadow type with a 92-96% accuracy in the Tetons). Voucher plants are housed at the University of Kansas McGregor Herbarium; voucher butterflies are housed at Iowa State University.

Project title: **Chloride Flux Monitoring**

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Objective: To provide a baseline for chloride flux exiting the park. Chloride flux is a proxy for heat flux.

Findings: Chloride flux, a surrogate for heat flow, was determined for the four rivers draining Yellowstone National Park for the water years 1983 through 1999, with the exception of 1995 and 1996. Using our measured average chloride flux to calculate annual heat flow from Yellowstone results in a value that is 20% greater than that calculated by Fournier et al., 1976. The Fall, Madison, Snake, and Yellowstone rivers have been estimated to discharge 94% of the chloride leaving the park. The flux for each river varied seasonally and annually, and is postulated to depend primarily on the flow of hot springs, which in turn depends on the height of the local water table, which rises during spring runoff, and varies annually in synchronism with changes in annual precipitation. The sum of the annual chloride fluxes for these four rivers varies as much as 20% from year to year. In support of the hypothesis of the influence of the height of the water table on the discharge of hot springs, chloride flux data collected during the fires of 1988 show that a large increase occurred in discharge of constant chloride concentration of Mammoth Outflow, a thermal stream of high chloride concentration that drains the surface features of Mammoth Hot Springs. These changes are explained by variations in the height of the local water table caused by the addition of large quantities of low-chloride water used to suppress the fire, rather than dilution of Mammoth Outflow by the direct addition of water.

Project title: **Remote Sensing-Based Geostatistical Modeling for Coniferous Forest Inventory and Characterization**

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Objective: The goal of this research is to develop, test, and demonstrate an integrated remote sensing

and geostatistical approach for the analysis of forest canopy structure, secondary forest regrowth, and forest fire history that takes advantage of the spectral and spatial correlation of ground phenomena and remotely sensed information. The project has four objectives: 1) Development of geostatistical models for forest biophysical parameters (height, density, basal area, leaf area index, and biomass) using multiscale satellite imagery and field data. 2) Calibration and verification of the models by field data and statistical means. 3) Testing the models in two specific forest characterization and inventory applications (forest cover type mapping and insect damage assessment). 4) Dissemination of the algorithms and procedures to the user community via online tutorials and software modules. Initial model development will focus on the lodgepole pine forest of the Greater Yellowstone Ecosystem

Findings: Key milestones achieved:
- Major summer 1999 field campaign in Yellowstone National Park – 330 sites sampled for forest biophysical characteristics
- Postdoctoral researcher hired
- LANDSAT 7 Thematic Mapper data of Yellowstone for July, August, September 1999 acquired from EROS Data Center and processed
- Project web page developed and is online: *www.kars.ukans.edu/forest*

Planned work for summer 2000 includes additional forest sampling in the eastern Central Plateau to complete the field data set. During 2000-01, model development will continue, leading to field work in summer 2001 directed toward field checking of model predictions of forest parameters.

Project title: **Trace Element Content of Cervid Antlers**

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Objective: I am studying the strontium isotopic composition and the content of strontium and other trace elements in elk and deer antlers from selected national parks in the western U.S., including Yellowstone. The study will add to the general body of knowledge about the cycling of trace elements through the environment and increase our understanding of the biogeochemistry of strontium. The study will provide baseline data from which future changes may be gauged.

Findings: No significant findings to date with respect to trace element contents inasmuch as no analytical data are yet available. Evidence of antler-chewing/osteophagia by Yellowstone elk has been obtained, and this is likely related to the major and/or trace element content of the antlers/bones and the nutritional status of the elk. Fieldwork by me in the park in August and October l999 was directed primarily toward determining the geographic distribution and frequency of occurrence of antler-chew-

ing/osteophagic behavior through field observations of skeletal remains of dead animals and cast (shed) elk antlers, mostly on Yellowstone's northern range.

Project title:	**Development of Algorithms to Use with Satellite Images to Assess Annual Snow Melt and Green-Up in Yellowstone National Park**
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Additional investigators:	Donay Hanson, Kathy Hansen, Richard Aspinall

Objective: This thesis is a methodology for use in conjunction with satellite imagery to determine snow cover and green-up in Yellowstone National Park that can be used on a near real-time basis. The methodology includes an ARC Macro Language (AML) in ARC/INFO or an Avenue Script in ArcView to perform the algorithms that accurately identify changes in snow cover and green up. They will be accompanied by a descriptive text including instructions for use and assumptions. The overall objectives of the study are to use satellite imagery and, 1) develop a method to determine percent of ground covered by snow and changes in forage quantity (green-up); and 2) test the utility of the method to determine the relationship of snow cover and green-up to ungulate distribution.

Findings: Ground data was collected and is currently being analyzed. Preliminary analysis indicates that AVHRR band 5 most accurately predicts percent snow cover; however, further analysis is necessary. No results are available for the green biomass portion of the study at this time. The study is on schedule with completion of an AML scheduled for mid-February 2000.

Project title:	**The Impact of Bison in Riparian Areas of Soda Butte Creek in the Lamar Valley**
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Objective: The purpose of this research was to determine if the northern bison (*Bison bison*) herd in the

Lamar Valley of Yellowstone National Park was negatively impacting riparian ecosystems in the area of Soda Butte Creek. Relationships between the bison and two of the components of the creek's riverine environment, soil, and vegetation were examined, including the topographic and geologic factors influencing those components.

Findings: I concluded that the bison were not damaging riparian areas of Soda Butte Creek. However, the study was limited by parameters such as a static bison population, small study area, and a relatively short period of field research. A longer-term study conducted parkwide and contingent upon future bison management policy would be necessary to definitively determine whether bison are indeed damaging riparian or any other ecosystems within Yellowstone National Park.

Project title: **Hydrogeomorphic Approach to the Assessment of Wetlands in Yellowstone National Park**

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Objective: We collected data in five depressional wetlands in Yellowstone National Park. This data will be added to an existing database from Ninepipes National Wildlife Refuge and the Bandy Ranch. We collected data in the park due to lack of human disturbance and the probability that the wetlands sampled will remain in an undisturbed condition for reference purposes.

Findings: We have completed 100 percent of the data collection planned. We hope to collect data on two slope wetlands in 2000.

Project title:	**Inventory of Wyoming Resources**
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Objective: To collect information on the condition of forest ecosystems, estimate baseline (current) conditions and trends, and detect changes from those baselines and trends over time at the state and national level.

Findings: The inventory of Wyoming resources began in 1997 with installation of the ground locations. The installation was completed that same year and approximately 1/3 of the locations are re-measured each year thereafter. This project has no conclusion; therefore, there is no project ending date.